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Prepared by: **Er. KUNAL SRIVASTAVA**

AIR-1 ESE 2012, AIR-44 GATE 2013

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This book is dedicated to all

Electronics Communication Engineers preparing for

GATE & Public sector examinations.

Er. R.K. Rajesh
(DIRECTOR)

GATE examination is one of the most prestigious competitive examination conducted for graduate engineers. Over the past few years, it has become more competitive as a number of aspirants are increasingly becoming interested in M.Tech & government jobs due to decline in other career options.

In my opinion, GATE exam test candidates' basics understanding of concepts and ability to apply the same in a numerical approach. A candidate is supposed to smartly deal with the syllabus not just mugging up concepts. Thorough understanding with critical analysis of topics and ability to express clearly are some of the pre-requisites to crack this exam. The questioning & examination pattern has changed over the past few years, as numerical answer type questions play a major role to score a good rank. Keeping in mind, the difficulties of an average student, we have composed this booklet. **We are thankful to Er. KUNAL SRIVASTAVA (AIR 1 ESE 2012, AIR 44 GATE 2013 in ECE) for preparing this booklet.**

In Electronics Communication Engineering, over 2,50,000 candidates appeared in GATE 2013 with 36,394 finally qualified. The cut-off marks for general category is 25. For more details log onto our institute's website **http://www.engineersinstitute.com/ Electronics**

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Best wishes for future career.

R.K. Rajesh

Director

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CONTENTS

1. ANALOG ELECTRONICS

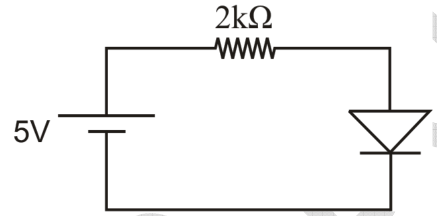
(1.) Consider a Si p.n diode with doping concentrations, $N_a = 10^{16} / cm^3$ and $N_d = 10^{15} / cm^3$. If $n_i = 1.5 \times 10^{10} / cm^3$ and zero bias junction capacitance = 0.5pF. The junction capacitance at an applied reverse bias of 2V is:

(a.) 0.5pF (b.) 0.245pF (c.) 0.168pF (d.) 2.0698pF

(2.) If at the doping levels of $N_D = 10^{17}/cm^3$. And $N_A = 10^{16}/cm^3$ and at a reverse bias of 1V, a Si diode shows a junction capacitance of 0.5pF, find the zero bias junction.

(a.) 0.76pF (b.) 1.16pF (c.) 0.86pF (d.) 1.31pF

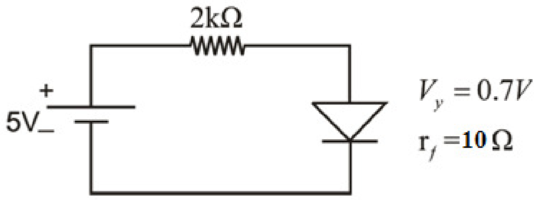
(3.) Consider a silicon p – n diode with reverse saturation current, $I_o = 10^{-13}$A. Find the power dissipated in the 2kΩ resistor.



(a.) 20mW (b.) 19.2mW (c.) 8mW (d.) 9.6mW

2 Linked Questions:

(4.) Find the power in the 2kΩ resistor if the diode has a cut in voltage = 0.7V and d.c. forward resistance = 10Ω

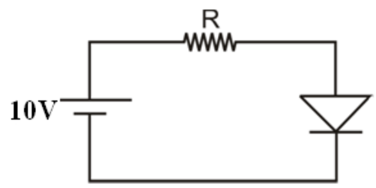


(a.) 8mW (b.) 16.7mW (c.) 9.15mW (d.) 19.1mW

(5.) Find the power consumed in the diode in the previous question

(a.) 1.5mW (b.) 9.15mW (c.) 1.4mW (d.) 0.046mW

(6.) If in the following circuit, diode has a power rating of 1mW, with a cut in voltage = 0.7V and zero forward resistance, find which of the following values of "R" will meet the requirement.



(a.) 3kΩ (b.) 7kΩ (c.) 3.97kΩ (d.) 6.5kΩ

SOLUTION

(1.) ANS: (b)

EXP:

$$C_j = \frac{C_{jo}}{\sqrt{1+\frac{V_R}{V_{bi}}}}$$

$$V_{bi} = \frac{kT}{q}\ln \frac{N_a . N_d}{n_i^2}$$

(2.) ANS: (a)

EXP:

$$c_j = \frac{C_{jo}}{\sqrt{1+\frac{V_R}{V_{bi}}}}$$

(3.) ANS: (d)

EXP:

Using diode equation and K.V.L

$$\Rightarrow 5 = 2\times10^3\times10^{-13}\left[e^{\frac{V_D}{0.026}}-1\right]+V_D$$

$$\Rightarrow V_D = 0.62V \text{ (by hit and trial)}$$

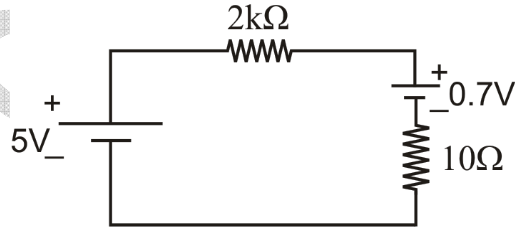
$$\therefore \mathrm{I}_D = 2.2mA$$

$$\therefore Power = (2.2mA)^2\times 2k\Omega = 9.68mW$$

(4.) ANS: (c)

EXP:

Replace the diode by its piecewise linear model



$$\therefore \mathrm{I}_D = \frac{5V-0.7V}{2.01k\Omega} = 2.14mA$$

$$\therefore Power = 9.15mW$$

(5.) ANS: (a)

EXP:

Power consumed in diode = sum of powers consumed in the V_γ and r_f.

$$= V_\gamma . I_D + (I_D)^2 . r_f$$

$$= 1.54mW$$

Mind that 1.54mW + 9.15mW = 10.69mW

= power delivered by the 5V source

(6.) ANS: (b)

EXP:

The power consumed in the diode must not exceed 1mW.

$$\therefore I_D \leq \frac{1mW}{0.7V} = 1.43mA$$

$$\therefore R \geq \frac{10V - 0.7V}{1.43mA} = 6.51k\Omega$$

$$thus,\ R \geq 6.51k\Omega$$

2. COMMUNICATION

(1.) For an A.M. signal $x(t) = A_c \;\; 1+\frac{1}{\sqrt{2}}\sin 10t \;\; .\cos 10^6 t$ find the power efficiency?

(a.) 25% (b.) 20% (c.) 70.7% (d.) 56.56%

(2.) For an A.M signal $x(t) = 10 \;\; 1+0.5\cos(2\pi.10^3.t) \;\; \cos 10^6 t$ find the upper side band power and modulated signal bandwidth.

(a.) 3.125W, 2kHz (b.) 6.25W, 2kHz (c.) 3.125W, 1kHz (d.) 6.25W, 1kHz

(3.) In commercial T.V, picture signals are transmitted by …………….. and speech signals by ……………… modulation.

(a.) S.S.B., F.M (b.) F.M, V.S.B (c.) F.M., S.S.B (d.) V.S.B., F.M.

<u>2 Linked Questions</u>

(4.) A signal by $f(t) = 2\cos(1002\pi t) + 20\cos(1000\pi t) + 2\cos(998\pi t)$ has been radiated with an antenna of resistance 10Ω. Find modulation index and total power transmitted.

(a.) μ = 0.1, P_t = 201W (b.) μ = 0.1, P_t = 201W (c.) μ = 0.1, P_t = 20.1W (d.) μ = 0.2, P_t = 20.4W

(5.) The bandwidth and the power of the upper sideband in the previous question are

(a.) 2Hz, 0.2W (b.) 4Hz, 0.4W (c.) 2Hz, 0.4W (d.) 4Hz, 0.2W

(6.) An A.M. transmitter current is given by 10A with 40% single tone modulation, Find A.M. transmitter current with 80% single tone modulation.

(a.) 11.05A (b.) 8.18A (c.) 9.045A (d.) 12.22A

<u>2 Linked Questions</u>

A carrier signal $c(t) = 10.\cos(2\pi \times 10^6 t)$ is simultaneously amplitude modulated with two message signals of frequencies 1kHz and 2kHz with modulation indices of 0.4 and 0.3 respectively

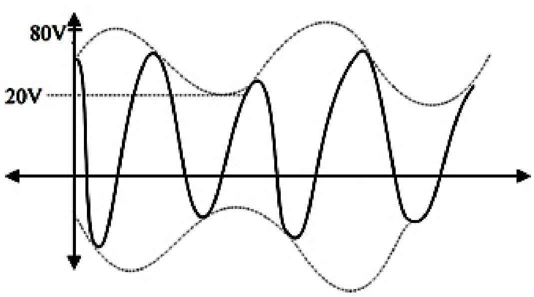
(7.) Find overall modulation index and total power transmitted if antenna resistance = 1Ω

(a.) 0.5, 56.25W (b.) 0.5, 62.25W (c.) 0.7, 56.25W (d.) 0.7, 62.25W

(8.) Find the bandwidth and power in the two sidebands corresponding to 2kHz modulating frequency.

(a.) 4kHz, 2.25W (b.) 3kHz, 4W (c.) 3kHz, 2.25W (d.) 4kHz, 4W

(9.) An amplitude modulated signal is plotted.



Find the modulation index and amplitude of the carrier wave

(a.) 0.6, 60V (b.) 0.4, 50V (c.) 0.4, 60V (d.) 0.6, 50V

SOLUTION

(1.) **ANS: b**

EXP:

$$\eta = \frac{\mu^2}{2+\mu^2}$$

(2.) **ANS: a**

(3.) **ANS: d**

(4.) **ANS: c**

EXP:

$$P = \frac{Ac^2}{2R}\ 1+\frac{\mu^2}{2}\ \ watt$$

(5.) **ANS: a**

(6.) **ANS: a**

(7.) **ANS: a**

(8.) **ANS: a**

(9.) **ANS: d**

3. CONTROL SYSTEM

(1.) The transfer function of a system in Laplace transform of

(a.) Impulse response (b.) Step response (c.) Ramp response (d.) None of these

(2.) The open loop D.C. gain of a unity negative feedback system with closed loop transfer function $\frac{s+4}{s^2+7s+13}$ is:

(a.) $\frac{4}{13}$ (b.) $\frac{4}{9}$ (c.) 4 (d.) 13

(3.) If unit step response of a system is $C(t)=1-e^{-3t}$ for $t\geq 0$, its transfer function is,

(a.) $\frac{3}{s(s+3)}$ (b.) $\frac{3}{(s+3)}$ (c.) $3/s$ (d.) $\frac{3}{(s+3)}$

(4.) The inverse Laplace transform of

$$F(s)=\frac{s+6}{s(s^2+4s+3)}$$

(a.) $\left(2+\frac{5}{2}.e^{-t}+\frac{1}{2}.e^{-3t}\right).u(t)$ (b.) $\left(2-\frac{5}{2}.e^{-t}+\frac{1}{2}.e^{-3t}\right).u(-t)$

(c.) $\left(2-\frac{5}{2}.e^{-t}+\frac{1}{2}.e^{-3t}\right).u(t)$ (d.) $\left(2+\frac{5}{2}.e^{-t}-\frac{1}{2}.e^{-3t}\right).u(t)$

(5.) Find the inverse Laplace transform

$$F(s)=\frac{s+6}{(s+2)(s^2+2s+1)}$$

(a.) $\left(e^{-2t}-e^{-t}+t.e^{-t}\right).u(t)$ (b.) $\left(e^{-2t}+e^{-t}+t.e^{-t}\right).u(t)$

(c.) $\left(-e^{-2t}+e^{-t}-t.e^{-t}\right).u(t)$ (d.) $\left(e^{-2t}-e^{-t}+t^2.e^{-t}\right).u(t)$

(6.) Find the inverse Laplace transform of $F(s)=\frac{s+9}{s^2+6s+25}$

(a.) $\left(e^{-3t}.\cos 4t+\frac{3}{2}.e^{-3t}.\sin 4t\right).u(t)$ (b.) $\left(e^{-3t}.\cos 4t+\frac{2}{3}.e^{-3t}.\sin 4t\right).u(t)$

(c.) $\left(\frac{2}{3}e^{-3t}.\cos 4t+.e^{-3t}.\sin 4t\right).u(t)$ (d.) $\left(\frac{3}{2}e^{-3t}.\cos 4t+.e^{-3t}.\sin 4t\right).u(t)$

(7.) Find the inverse Laplace transform of $f_1(s)=\frac{s}{s^2-9}$; $and\ f_2(s)=\frac{2}{s^2-9}$

(a.) $\cos h3t.u(t)$; $\frac{2}{3}\sin 3t.u(t)$ (b.) $\cos h3t.u(t)$; $\frac{2}{3}\sin h3t.u(t)$

(c.) $\cos 3t.u(t)$; $\frac{2}{3}\sin h3t.u(t)$ (d.) $\cos 3t.u(t)$; $\frac{2}{3}\sin 3t.u(t)$

SOLUTION

(1.) **ANS:** (a)

(2.) **ANS:** (b)

EXP:

$$\frac{G(s)}{1+G(s).H(s)}=\frac{s+4}{s^2+7s+13}$$

Put H(s) = 1, find G(s) and put s = 0 (for d.c.)

(3.) **ANS:** (b)

EXP:

Impulse response, h(t) = $\frac{d}{dt}c(t)$

$$H(s)=L\left[h(t)\right]$$

(4.) **ANS:** (c)

EXP:

$$F(s)=\frac{s+6}{s(s+1)(s+3)}=\frac{A}{s}+\frac{B}{s+1}+\frac{C}{s+3}$$

$$A=\frac{6}{3}=2$$

$$B=\frac{5}{-1\times 2}=\frac{-5}{2}$$

$$C=\frac{3}{-3\times -2}=\frac{1}{2}$$

(5.) **ANS:** (a)

EXP:

$$F(s)=\frac{1}{(s+2)(s+1)^2}=\frac{A}{(s+2)}+\frac{B}{(s+1)}+\frac{C}{(s+1)^2}$$

$$A=\frac{1}{(-1)^2}=1$$

$$B=\frac{-1}{(-1+2)}=-1$$

$$C=\frac{1}{(-1+2)}=1$$

$$\therefore F(s)=\frac{1}{(s+2)}-\frac{1}{(s+1)}+\frac{1}{(s+1)2}$$

$$\therefore f(t)=\left(e^{-2t}-e^{-t}+t.e^{-t}\right).u(t)$$

(6.) **ANS:** (a)

EXP:

$$F(s)=\frac{s+9}{s^2+6s+25}=\frac{s+3+6}{(s+3)^2+(4)^2}$$

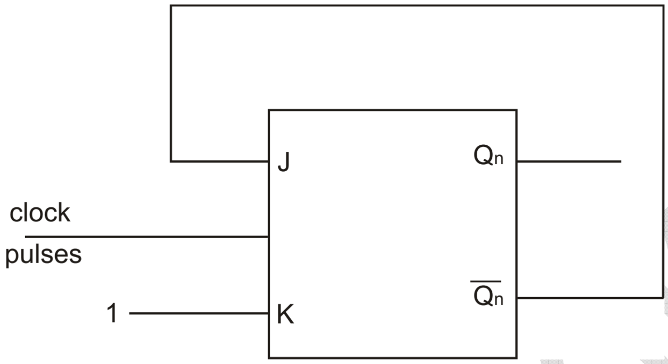
$$=\frac{s+3}{(s+3)^2+(4)^2}+\frac{3}{2}\times\frac{4}{(s+3)^2+(4)^2}$$

$$= \quad e^{-3t}.\cos 4t+\frac{3}{2}.e^{-3t}.\sin 4t \quad .u(t)$$

(7.) **ANS:** (b)

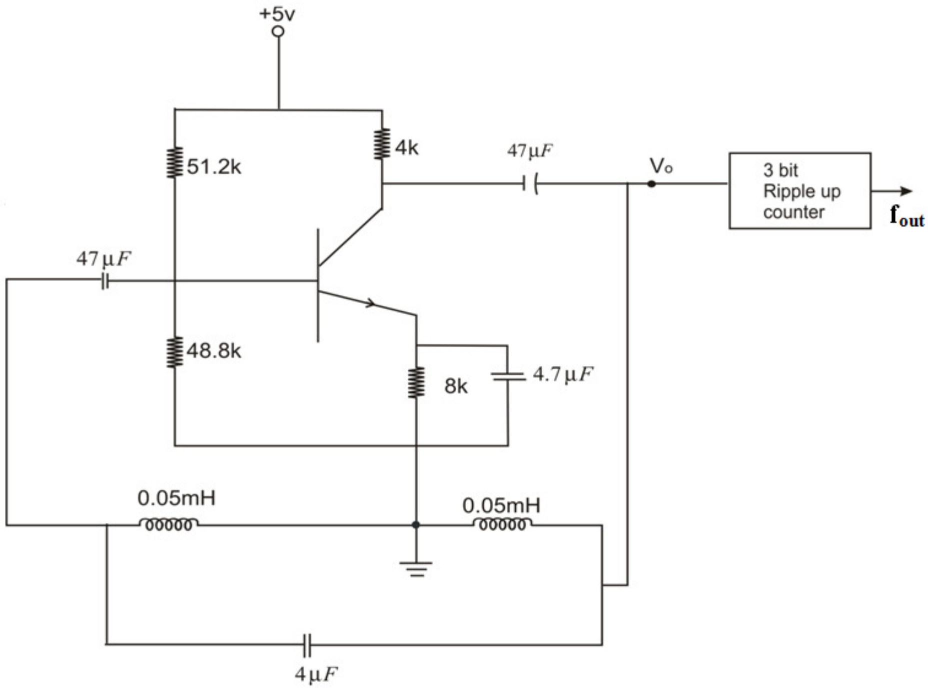
4. Digital Electronics

(1.) Assuming that initially $Q_n = 0$, now the clock pulses are given, fine the resulting sequence at $\overline{Q}_n$.



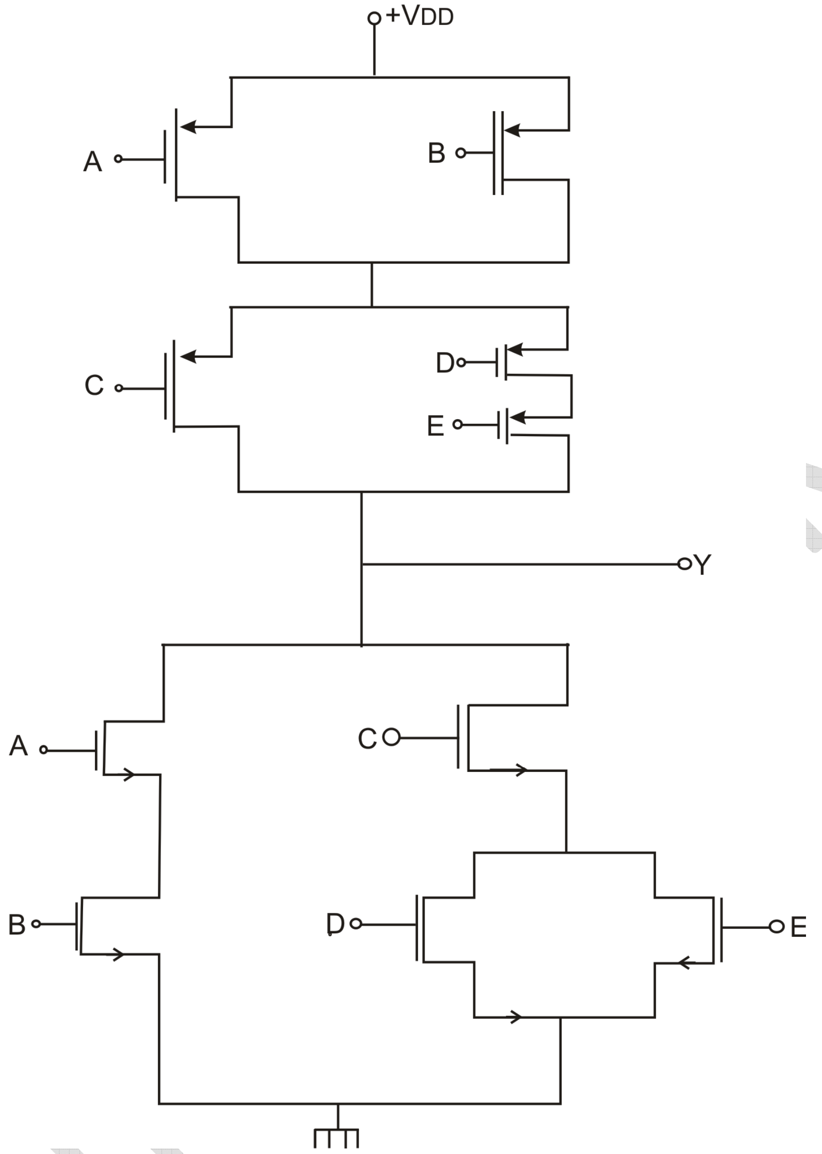
(a.) 0, 0, 0, 0…
(b.) 1, 1, 1, 1…
(c.) 0, 1, 0, 1, 0, 1…
(d.) 1, 0, 1, 0…

(2.) Fine the output frequency of the circuit.



(a.) 49.76 MHz
(b.) 995.22 Hz
(c.) 6.25 KHz
(d.) 7.961 KHz

(3.) Find the expression for the output logic function.



(a.) AB + C(D + E)

(b.) (A+B) .C + (D + E)

(c.) AB + C. (D+E)

(d.) $\overline{AB + C.(D + E)}$

SOLUTION

(1.) **ANS: c**

EXP:

The input changes as 11 → 01 → 11 → 01, use JKFF truth table.

(2.) **ANS: b**

EXP:

The frequency of Hartley's oscillator = 7961.8Hz. The output of mod – 8 counter

$$= \frac{7961.8Hz}{8}$$

(3.) **ANS: d**

EXP:

NMOS → Parallel → OR

NMOS → series → AND

Reverse for PMOS

Put complement on the final expression